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AUTHOR Crone, Linda J.; Tashakkori, Abbas
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ABSTRACT

Findings from a study that sought to determine the degree to which effective schools are uniformly effective for all students regardless of socioeconomic status (SES) are presented in this paper. Data were derived from a large nationally representative set of 989 schools that were involved in the National Education Longitudinal Study (NELS) of 1988, a project involving eighth graders. Questionnaires were also administered to students, parents, and schools. Regression analysis was used to classify the schools into effectiveness levels and compare their variance of student achievement. Findings indicate that effective schools were homogeneously effective for students only when the student population was homogeneous. When high- and low-SES schools were examined separately, upper-SES schools had the smallest variation in student achievement in the effective schools. Conversely, the lower SES schools had the smallest variation in student achievement in the ineffective schools. The results point to the importance of considering the variance of student achievement and its relationship to SES variables in studies of school effectiveness. Three tables are included. (21 references) (LMI)

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VARIANCE OF STUDENT ACHIEVEMENT IN EFFECTIVE AND INEFFECTIVE SCHOOLS: INCONSISTENCIES ACROSS SES CATEGORIES

by

Linda J. Crone

Louisiana Department of Education
Bureau of School Accountability

AND

Abbas Tashakkori

College of Education
Louisiana State University
Baton Rouge, LA 70803

EA 024 066

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ABSTRACT

The issue of equity in education has attracted considerable attention in recent years, especially in relation to school effectiveness. A major unanswered question pertains to the degree to which effective schools are uniformly effective for all students regardless of SES background. The present study is an attempt to answer this question using a large nationally representative set of 989 schools which were involved in the National Education Longitudinal Study (NELS) of 1988, a project involving eighth graders. Using regression analysis, the schools were classified into effectiveness levels, and compared on their variance of student achievement. In effective schools, there was a significant positive correlation between variance of achievement scores and variance of student SES, a trend that was not present in ineffective schools. It is concluded that effective schools are homogeneously effective for students only when the student population is homogeneous. When high and low SES schools were examined separately, upper SES schools had the smallest variation in student achievement in the effective schools. Conversely, the lower SES schools had the smallest variation in student achievement in the ineffective schools. The results point to the importance of considering the variance of student achievement and its relation to SES variables in studies of school effectiveness.

VARIANCE OF STUDENT ACHIEVEMENT IN EFFECTIVE AND INEFFECTIVE SCHOOLS: INCONSISTENCIES ACROSS SES CATEGORIES

The research area of school effectiveness has undergone considerable development over the past 25 years, yet much controversy still exists as to the actual definition of school effectiveness, the methods of measurement, and the interpretation of results. Most educational research has used student academic achievement as the criterion for effectiveness. This is a limited measure of effectiveness, but academic achievement seems to be of the greatest concern to educators, policy makers, and parents, plus having the advantage of being the most measurable of school outcomes (Good and Brophy, 1986). Even though various methods have been suggested for measuring academic achievement, the most commonly used methods utilize residual scores at the school level, and determine effectiveness by performance above or below that which was predicted (Brookover, Schweitzer, Schneider, Beady, Flood, and Wisenbaker, 1979; Klitgaard and Hall, 1974; Mandeville and Anderson, 1987; Teddlie, Kirby, and Stringfield, 1989). Predicted scores are most commonly based on a regression analysis using socioeconomic status as the predictor variable.

Other methods of classification use mean achievement scores in various types of analysis. One way of determining school effectiveness with mean achievement scores is to make a simple comparison of one school's standing with another (Edmonds and Frederiksen, 1979). Other school effectiveness algorithms look at trends of improvement, or rates of gains (Abalos, et al. 1985; Frechtling, 1982).

Disaggregation of data for different subgroups within a school is another method used to determine school effectiveness with mean achievement scores (Levine and Lezotte, 1990). Many educational researchers express concern about the use of aggregate scores masking differences in group effects within the school (Cuban, 1983; Edmonds and Frederiksen, 1979; Frederick and Clauset, 1985; Good and Brophy, 1986; Good and Weinstein, 1986). Although it is not a commonly used method, Levine and Lezotte (1990) strongly advocate disaggregation of data by student SES and race/ethnicity to ensure that schools are equitably effecting different subgroups within a school.

Ron Edmonds was one of the first to bring up this question of equity in education. Edmonds and Frederiksen (1979) suggested that schools may not be equally effective for different groups within the school. They stratified the students according to race and home background and compared mean achievement scores for the pupil subgroups. They found that schools that were effective for one group were not always effective for others. Economic factors appeared to account for the biggest differences in student achievement (more than racial differences). Therefore, the characteristics of effective schooling for low SES may be different from those of middle or high SES. Two studies that demonstrated this across schools are Hallinger and Murphy (1986), and Teddlie, Falkowski, Stringfield, Desselle, and Garvue (1984).

Frederick and Clauset (1985) addressed the equity concern by using different algorithms to classify a school as effective or ineffective. Some algorithms examined included a comparison of mean achievement to the national norm, a comparison of school gains to city wide-gains, and a reduction in the gap of achievement for subgroups based on SES. The six

different algorithms used for the analysis produced inconsistent classification results for school effectiveness. They concluded that the use of aggregate scores often masks critical differences among various cohort groups within a school. Other studies expressing similar concerns are Dyer, Lynn, and Patton (1969); Lang (1991); and Marco (1974).

Very little attention has been given to the actual variance of overall scores within a school. Following the line of reasoning of those who believe in equity in education, one would conclude that the more effective schools would have less variance in achievement scores. The only study found that actually compares variance in achievement scores for effective versus ineffective schools reports just the opposite. Lark, Blust, and Coldiron (1984) conducted a study of Pennsylvania schools, in which they looked at the variance of schools which had been classified as effective or ineffective according to the regression method, and found that those schools labelled as effective actually had greater variance than those rated as ineffective. They also classified the schools as effective/ineffective according to the differences in mean achievement between the high and low-SES students in each school. In accordance with the equity issue, they classified schools with the smallest gaps in achievement between SES levels as "effective" and those with the largest gaps as "ineffective". They found that this classification was totally inconsistent with the regression algorithm. In fact, they reported that the larger differences between mean achievement were found in the "effective" schools. Their contention was that the larger differences in the "effective" schools was as it should be, since the purpose of schools is to maximize each student's potential--which would widen the dispersion of student outcomes.

On the contrary, a four year study of the London schools (Mortimore and Sammons, 1987) found that effective schools were effective for all groups, and less effective schools were less effective for all groups. The overall differences in SES were not completely removed in effective schools, but they stated that "..on the average a student from a blue-collar worker's family attending an effective school achieved more highly than one from a white-collar family background attending one of the least effective schools." (Mortimore and Sammons, 1987, p.6).

The question of how to interpret dispersion of achievement scores came to the attention of the researchers when asked to explain gaps in achievement scores between SES subgroups. Following the philosophy of equity in education, large gaps between subgroups were interpreted as an indication of ineffectiveness, at least for the lower SES group of students. The same issue that Edmonds and Frederiksen introduced 12 years ago then came to mind regarding whether these schools which are classified as "effective" using regression methods are actually effective for all students within the schools. Also, the question arose as to whether gaps in achievement for subgroups within a school actually indicated ineffectiveness? As demonstrated by the above review of the existing literature on the subject, there is very little empirical evidence to answer these questions.

The present study is an attempt to answer these questions by examining the within school standard deviations of a national sample of schools which are categorized with varying degrees of effectiveness and ineffectiveness. Obviously, student achievement is not only affected by the degree of school effectiveness, but also by other characteristics of the school, as well as the family SES background. If one can assume that in a highly effective school

almost all students perform well, such schools would be expected to have small variation of student achievement scores. The same assumption might be made regarding highly ineffective schools, in which almost all of the students perform below expected levels, leading to smaller variation of achievement scores. The assumptions have been borne out in recent studies of students' time-on-task in the classroom (Teddlie et al., 1989; Virgilio, Teddlie, and Oescher, 1991). In the present study, the accuracy of these assumptions will be tested through examination of variances within the effective and ineffective schools.

METHODS

Sample:

NELS is a data file compiled by the National Center for Education Statistics. The survey used a two-stage stratified sample design, with schools in the first strata and students within schools in the second. The schools were chosen from a database compiled by Quality Education Data, Inc., which provides a list of both public and private schools throughout the US. From about 39,000 schools containing grade eight, 1,734 schools were selected, of which 1,057 chose to participate. In each school 26 eighth graders were randomly selected, where available. In schools with less than 26 eighth grade students, all eligible students were included. Special education students were excluded, as were students who were not proficient in English. Schools excluded from the study were Bureau of Indian Affairs schools, special education schools, and vocational schools.

Data was collected from all students, parents, and schools participating in the study. Questionnaires were administered to students, parents, teachers, and school administrators. Other data included teacher ratings of students, plus a four section standardized test, including

mathematics, reading, science, and social studies. In addition to demographic information, the student questionnaires included information on locus of control and self-concept.

Eliminated from this study were schools that had less than 10 eighth grade students available. As the focus of the study was on school level variance, it was deemed inappropriate to consider variance with less than ten students in a school. Also eliminated were schools in which more than 50% of the students were enrolled in classes for the gifted as these schools were found to have disproportionally small variance. Out of the 1057 schools on the data tape, 989 were included in the analysis.

Variables and their measurement:

In addition to the student's scores for the four subject areas on the standardized test, NELS provided a standardized test composite for reading and math. This composite achievement score has a minimum of 25.45 and a maximum of 70.9, and is standardized to a score with a mean of 50, and a standard deviation of 10. The composite achievement score was used for this study.

Different indicators of socioeconomic status (SES) were used in an exploratory analysis to determine the best predictors of student achievement. One such indicator is a composite SES score provided in the NELS data set. It includes indicators of parent's educational level, parent's occupation, and family income. This score is standardized to a mean of 0 and standard deviation of 1, with an actual range of -2.97 through 2.56.

Parent education was provided from the parent questionnaire, when available, with the student questionnaire used for missing information. The data were coded as 1 for did not finish high school, up through 6 for a Ph.D., M.D., with 7 for don't know and 8 for missing.

Parent occupation data was again taken from the parent questionnaire, and was recoded using the Duncan SEI scale (see Miller, 1991) which was used in High School and Beyond national project. The parents also supplied the information regarding family income. This coding ranged from 01 for no income to 15 for $200,000 or more.

For each student NELS provides the percent of students receiving free lunch in their school. This was coded as 0=None, 1=1-5%, 2=6-10%, 3=11-20%, 4=21-30%, 5=31-50%, 6=51-75%, 7=76-100%, and 8=Missing. Likewise, there is data for each student on the percent of minority students within their school, with coding similar to that for percent free lunch. School type, in terms of being public or private is also provided in the data set. The codes for type of school are 1=public school, 2=Catholic school, 3=Private school, other religious affiliation, 4=Private school, no religious affiliation. School size is also available in categories. The categories are: 1=1-49 students, 2=50-99, 3=100-199, 4=200-299, 5=300-399, and 6=400+. The regions of the country from which the schools were selected are defined as 1=Northeast, 2=North Central, 3=South, 4=West, 5=missing. The urbanicity classification has values of 1=urban, 2=suburban, and 3=rural.

Procedure:

Using the standardized test composite score for reading and math, the mean and standard deviation of achievement scores were calculated for each school. Means were also calculated for each of the SES indicators. These indicators were: parental education, parental occupation, family income, and the composite SES score. In addition to these, percentage of students receiving free lunch was obtained and considered as another indicator of school average SES. Demographic variables of percent of minority students, overall school

enrollment, school type, region, and urbanicity were also obtained for each school. A regression was then run to predict the average student achievement from school level SES and demographic data.

Two different regression models were examined: (a) a regression using only the composite SES score, (b) a forward stepwise regression using the means for each school on percent of students receiving free lunch, parent education, parent occupation, family income, percent minority, enrollment, type, region, and urbanicity. Due to multicollinearity, inclusion of all SES indicators in the model, along with the SES composite scores was not possible. Hence, the second strategy mentioned above utilized a forward regression analysis, entering the statistically significant predictors in the model while controlling the minimum tolerance of the predictors (see Norusis, 1990). The second model yielded better results indicating the best predictors to be parent education, percent minority, and family income. The R^2 predicting the composite student achievement score from the composite SES was .678 ($p<.0001$), where the R^2 predicting student achievement from parent education, percent minority and family income was .729 ($p<.0001$). Although significant, the variables of urbanicity and region were excluded from the model, as they each contributed less than .005 to the R^2.

In line with previous research, the residuals from the regression analysis were used to classify schools as effective or ineffective. The residual is an indicator of the effect of the school after the influence of socioeconomic status has been partialed out. Consequently, a positive residual indicates that the student's achievement scores are higher than was predicted for that school, based on the SES of that school. A negative residual shows that the students

have performed below what was predicted of them. Based on these residuals, the schools were divided into six groups (cut-off points of 10, 30, 50, 70, and 90 percentiles) according to the degree of effectiveness: (a) those schools with residuals falling below the 10th percentile were labelled highly ineffective (Group -3); (b) schools with residuals between the 10th and 30th percentile were called moderately ineffective (Group -2); (c) schools with residuals between the 30th and 50th percentile were referred to as ineffective (Group -1); (d) those schools which had residuals from the 50th to the 70th percentile were labelled effective (Group +1); (e) those with residuals between the 70th and 90th percentile were considered moderately effective (Group +2), and those above the 90th percentile were called highly effective (Group +3). The number of schools in each of these six categories were 99, 192, 200, 198, 198, and 98, respectively.

These groups were analyzed by looking at correlations between the school aggregated standard deviation of student achievement, mean student achievement, average SES, standard deviation of SES, and residual scores. The aggregation of the standard deviation was done by summing the school level standard deviations for each group and dividing by the number of schools in each group.

Also, average statistics were compared for each of the six groups on achievement, SES, school type, residuals, standard deviation of SES and standard deviation of achievement. This comparison was conducted for the groups as a whole, and for each group divided into high and low SES. The two categories of SES were selected by rank ordering the schools according to the composite SES score, and selecting the top 30% as high SES and the bottom 30% as low SES.

RESULTS AND DISCUSSION

An examination of the correlation between standard deviation of student achievement and regression residuals indicates that there is a relationship between the effectiveness of a school and the within school standard deviation of student achievement. In two of the effective school categories significant negative correlations were found between the variables (Table 1). These results suggest that as the schools become more effective, the standard deviation of student achievement becomes smaller.

***** Insert Table 1 about here *****

Table 1 also illustrates the correlations found between the standard deviation of student achievement and the actual mean student achievement. This demonstrates a curvilinear relationship between the two variables. In the highly effective and moderately effective schools there was a strong negative correlation between standard deviation of student achievement and mean student achievement: as the achievement scores increased the variance decreased. In the highly ineffective and moderately ineffective schools the reverse occurred: a strong positive correlation indicated that as the achievement scores increased the standard deviation also increased. Consequently, in effective schools the higher the achievement scores, the smaller the standard deviation; and in ineffective schools the *lower* the achievement scores, the smaller the standard deviation. This pattern of correlations was found not only in the outlier categories, but was also present in the effective and ineffective groups.

The correlation between variation of achievement and variation of SES within the 6 levels of school effectiveness shows a strong positive relationship in highly effective schools and diminishes to a negative relationship in highly ineffective ones (Table 1). In other words,

highly effective schools that were homogeneous in SES had homogeneous achievement scores. On the other hand, the highly ineffective schools that were highly homogeneous in SES did not have homogeneous achievement scores. A tentative conclusion from these correlations between variation in achievement and variation in SES might be that highly effective schools do *not* eliminate the SES-related variation in achievement scores.

The means for each group on the different variables are shown in Table 2. One can see that, except for the mean achievement and standardized residuals (ZResid), there are very few differences between the groups. Slight differences are apparent in the standard deviation of achievement for the outlier groups. The fact that the standard deviation is smaller for the outlier groups might possibly be attributable to the floor and ceiling effect. There is very little difference in the SES or standard deviation of SES for the different categories.

***** Insert Table 2 about here *****

In order to further explore the factors influencing the above correlations between the mean and variance of student achievement, an examination of the school level variables for each category of effectiveness separated by high and low SES was conducted. Table 3 presents these means and standard deviations. In examination of data in that table, three important aspects need to be pointed-out: a) Even in highly *effective* low SES schools the students are still not performing at as high a level as the most *ineffective* of the high SES schools; b) Gaps in achievement scores between the upper and lower SES groups remain relatively consistent regardless of the effectiveness of the schools. The highly effective groups have a 10.99 gap (60.37-49.38), where the highly ineffective groups have a gap of 10.85 (51.77-40.92); and c) On the other hand, the difference made on the students by the

effectiveness of the school is consistent whether the group is high or low SES. The difference between the student achievement scores between the least and most effective high SES schools is 8.6 points. The difference in scores between the least and most effective low SES schools is 8.46 points. In other words, the effectiveness of the school has as great an impact on low SES students as on high SES students.

Among the upper SES schools, achievement and standardized residuals (Zresid) are as expected, with both decreasing as the categories become less effective. A difference is evident in the standard deviation of achievement for the effective versus the ineffective schools. The more effective the school the smaller the standard deviation in achievement. The ineffective upper SES schools have the *highest* degree of within school variation in student achievement, even higher than any of the low SES school categories. This suggests that coming from a high socioeconomic background does not help all students.

***** Insert Table 3 about here *****

When examining the type of school, one can see that the most effective and the most ineffective schools have the highest average scores, which indicates that these two categories have more private schools than the other categories. Among the lower SES schools, the standard deviation of achievement gets smaller as the schools decrease in effectiveness. The results can be interpreted to mean that the very ineffective schools are uniformly ineffective for all students.

CONCLUSIONS

The results indicate that the standard deviation of student achievement is, in most cases, dependent upon socioeconomic factors, and that no examination of variation of student achievement and its relationship to school effectiveness can be complete without consideration of such factors.

The results of this study do not confirm the findings of Lark et al. (1984). When making a simple comparison of variation in student achievement for effective versus ineffective schools, no differences were seen. Only when correlations and contextual differences were examined did any differences emerge.

The overall analysis, which yielded very little difference in variation of scores for effective versus ineffective schools, would appear to confirm Mortimore and Sammons (1987) findings. When looking at the data separately for high and low SES, though, the findings of this study are different than what was found in the London schools or the Louisiana schools. Mortimore and Sammons reported that a lower SES student in a very effective school outscored a higher SES student in a very ineffective school. In the Louisiana School Effectiveness Study, Phase II, Teddlie, et al., (1984) found that effective low SES schools outscored ineffective *middle* SES schools.

This study found, when examining school level data, that the most effective low SES schools still didn't score as well as the least effective high SES schools. This disparity in findings between this study and the Louisiana study may by that this compares extreme low SES to extreme high SES, where the Louisiana study compared low SES to middle SES.

Also, the London schools compared students from "blue collar" homes to students from "white collar" homes which may not contain the extremes used here.

The negative correlations between residuals and standard deviation of student achievement in effective schools does show some indication that as the effective schools increase in effectiveness, their standard deviation decreases. The major differences in variation, though, were found when the data was analyzed separately for high and low SES schools. It was then found that the upper SES schools had the smallest variation in the effective schools. Conversely, the lower SES schools had the smallest variation in the ineffective schools.

In other words, the effective schools are being effective for the majority of the higher SES students and for *some* of the lower SES students. In the ineffective schools, the larger standard deviation for high SES students shows that some of these students are still achieving (in spite of the school), where the smaller standard deviation in the low SES group demonstrates that none of these students are able to achieve without the help of the schools.

These results seem logical when one considers that the higher SES students generally have more encouragement and opportunities to learn outside of school; hence, when this is combined with good opportunities to learn within the school, the chances of success are high. Even when these high SES students do not have the opportunities to learn in school, some are getting enough help elsewhere to produce high achievement scores. The lower SES students generally have only one chance for success, and that is with the help of the schools. Unfortunately, some of these students are so suppressed by their home environment that the best of schools cannot reach them. When these students have no help from either the school or the home, there is very little chance of success.

The fact that the gap between achievement scores is the same for effective schools as it is for ineffective schools demonstrates that even the "very good" schools are not accomplishing the goal of equity in education. The effectiveness of the schools does not appear to have any influence on lessening the gap between achievement scores for different SES levels. If equity is to be realized, increased efforts must be made to improve the achievement levels of low SES students.

These findings for eighth grade students may or may not generalize to other grade levels. Further analysis of the variance issue at other grade levels is suggested. The obvious need in research is to try to more clearly identify those low SES students who are not being reached, even by the effective schools. An identification of these children would be the first step in making education more equitable.

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Table 1

Pearson Correlation Coefficients between standard deviation of student achievement with standardized residuals (r_1), standard deviation of student achievement with mean student achievement (r_2), and standard deviation of student achievement with standard deviation of SES (r_3)

Category	r_1	r_2	r_3
Highly Effective (n=98)	-.2389*	-.5085**	.4298**
Moderately Effective (n=198)	-.1153	-.3811**	.4360**
Effective (n=198)	-.1932**	-.1002	.3417**
Ineffective (n=200)	-.0601	.0891	.2066**
Moderately Ineffective (n=192)	.0517	.3843**	.1485*
Highly Ineffective (n=99)	.1877	.5762**	-.1351

* $p < .05$
** $p < .01$

Table 2

Average statistics for each effectiveness category*: means for achievement, standard deviation of achievement, SES composite, standard deviation in SES, standardized residuals (z residuals), and school type**

	Effectiveness Category					
	+3 (n=98)	+2 (n=198)	+1 (n=198)	-1 (n=200)	-2 (n=192)	-3 (n=99)
Achievement						
Mean	55.18	53.22	50.97	49.30	47.83	46.16
Standard Deviation	7.87	8.52	8.92	8.71	8.77	8.22
SES						
Mean	-.05	-.06	-.102	-.126	-.11	-.02
Standard Deviation	.61	.62	.62	.61	.60	.59
z-Residual	1.68	.87	.275	-.23	-.88	-1.75
Type	1.55	1.38	1.23	1.26	1.23	1.53

*Effectiveness categories are defined as:

+3=highly effective
+2=moderately effective
+1=effective
-1=ineffective
-2=moderately ineffective
-3=highly ineffective

** Type is defined as:

1=public
2=Catholic school
3=Private school, other religious affiliation
4=Private school, no religious affiliation

Table 3

School aggregated statistics for effective and ineffective school categories within upper and lower SES schools

	UPPER SES						LOWER SES					
	Effectiveness Category*						Effectiveness Category*					
	+3 (n=30)	+2 (n=52)	+1 (n=53)	-1 (n=52)	-2 (n=51)	-3 (n=35)	+3 (n=27)	+2 (n=42)	+1 (n=51)	-1 (n=67)	-2 (n=62)	-3 (n=31)
Achievement												
Mean	60.37	58.48	55.67	54.54	53.28	51.77	49.38	47.91	45.19	45.05	43.47	40.92
SD	6.56	7.61	8.70	8.57	9.37	9.07	8.44	8.65	8.48	8.41	7.86	7.03
SES												
Mean	.61	.57	.46	.47	.50	.63	-.69	-.65	-.63	-.60	-.60	-.59
SD	.57	.55	.59	.58	.56	.53	.63	.63	.63	.63	.61	.63
z-Residual	1.63	.87	.28	-.21	-.82	-1.75	1.67	.89	.29	-.24	-.56	-1.74
Type**	2.36	2.15	1.70	1.63	1.66	2.26	1.04	1.05	1.00	1.03	1.00	1.00

*Effectiveness categories are defined as:

+3=highly effective
+2=moderately effective
+1=effective
-1=ineffective
-2=moderately ineffective
-3=highly ineffective

** Type is defined as:

1=public
2=Catholic school
3=Private school, other religious affiliation
4=Private school, no religious affiliation